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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Properties of subvisible cirrus clouds formed by homogeneous freezing" *by* B. Kärcher

Anonymous Referee #2

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General Comments:

The paper presents a discussion of properties of subvisible cirrus clouds based on theoretical calculations. The framework of the governing equations for cirrus formation via homogeneous ice nucleation is taken from earlier work of the same author (Kaercher and Lohmann, JGR, 2002) and applied here to subvisble cirrus. The simplified set of equations allows the author to derive scaling laws for ice particle sizes, number densities and other parameters of cirrus clouds. The author shows that vertical wind velocity is a key parameter, and that only for slow updraft and cold temperatures the forming cirrus is expected to remain subvisible for a sufficiently long time to be observed as 'subvisible'. Furthermore, the author shows that heterogeneous nucleation could control the formation of subvisible cirrus. The theoretical considerations presented in the paper should be of great interest to the readers of the journal, and I therefore recom-

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mend the paper to be published in ACP. The paper is well written and except for a few remarks/questions noted in 'Specific Comments' I have no objections.

Specific Comments:

p.6, The coefficients a1 and a3 can be found in Kaercher and Lohmann [2001], nonetheless they should be given here once more.

p.7 , para 3: It is somewhat unrealistic that the updraft ceases shortly after the saturation reaches its peak value. The additional cooling would lower the vapour pressure over ice, and the particles could grow to larger sizes. However, I assume that for slow to moderate updraft, the change in vapour pressure is small, and the simplification does not affect the results. Maybe one can infer a limit of the vertical velocity up to which this simplification is safe?

p.8, The coefficient β requires r_∞, but I cannot see where to take this value from.

p.9, Reference to Kent et al. [1993]: I could not directly find a discussion yielding eqs. (18), (19) and (20). Maybe a short discussion how these values were derived?

p.17, Which equation leads to the scaling laws (21) and (22)?

p.19, first line: should probably read 'apart from slip-flow corrections and ...'

p.19, eq. (29): Where comes the dependence of t_s on number density from? From the aforementioned dependence of the sedimentation velocity on particle radius and the definition of t_s one only sees the dependence of t_s on the radius. Furthermore, this dependence is dropped in the second expression, which I assume to be derived from (25).

p.19/21, Of course here the questions arises what happens to the particles once they have sedimented out of the nucleation layer (that is the air volume where particles nucleated). Sedimentation may not limit the lifetime of the cirrus, depending on the conditions below the nucleation layer. In fact, couldn't it be that the altitude region

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2, S68–S70, 2002

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where nucleation occurs is much less than the cited value of 750m, and that a large fraction of the 750m may be attributed to particles sedimenting through air masses in which never a particle nucleated? If this were the case, I would expect the 'lifetime' of subvisble cirrus to be rather distinct from the results presented in figure 6.

Interactive comment on Atmos. Chem. Phys. Discuss., 2, 357, 2002.

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2, S68–S70, 2002

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